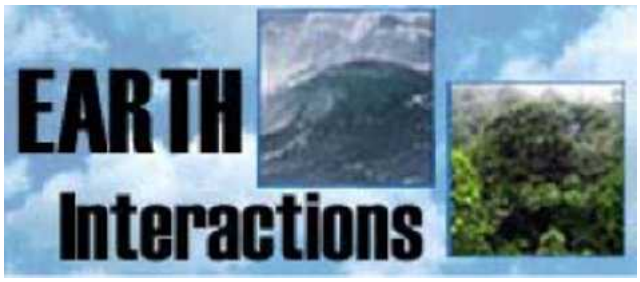

Validation of MODIS Active Fire Detection Products Derived from Two Algorithms

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ABSTRACT: Fire influences global change and tropical ecosystems through its connection to land-cover dynamics, atmospheric composition, and the global carbon cycle. As such, the climate change community, the Brazilian government, and the Large-Scale Biosphere–Atmosphere (LBA) Experiment in Amazonia are interested in the use of satellites to monitor and quantify fire occurrence throughout Brazil. Because multiple satellites and algorithms are being utilized, it is important to quantify the accuracy of the derived products. In this paper the characteristics of two fire detection algorithms are evaluated, both of which are applied to *Terra*'s Moderate Resolution Imagine Spectroradiometer (MODIS) data and with both operationally producing publicly available fire locations. The two algorithms are NASA's operational Earth Observing System (EOS) MODIS fire detection product and Brazil's Instituto Nacional de Pesquisas Espaciais (INPE) algorithm. Both algorithms are compared to fire maps that are derived independently from 30-m spatial resolution Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER)

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imagery. A quantitative comparison is accomplished through logistic regression and error matrices. Results show that the likelihood of MODIS fire detection, for either algorithm, is a function of both the number of ASTER fire pixels within the MODIS pixel as well as the contiguity of those pixels. Both algorithms have similar omission errors and each has a fairly high likelihood of detecting relatively small fires, as observed in the ASTER data. However, INPE's commission error is roughly 3 times more than that of the EOS algorithm.

KEYWORDS: Fire monitoring, MODIS, Validation, Satellite fire detection

6. Conclusions and discussion

The primary conclusion is that both algorithms do a fairly good job detecting fires, as compared to the fire detection from ASTER imagery. It is encouraging to see that the results from the error matrix analysis are similar to those of the logistic regression modeling. The algorithms show similarities in the detection probabilities from the logistic regression and in the probability of omission error from the error matrix approach. However, the EOS product shows much lower commission error probabilities.

It is worth noting that by comparing to ASTER data, we are only considering fires within the look-angle range of ASTER's SWIR bands: ±8.55°. There is also a chance that clouds can obscure fire detection from both ASTER and MODIS fire detection algorithms. However, any bias as a result of look-angle cloud cover should be consistent between the INPE and EOS ASTER comparison. So, the comparison presented here is legitimate despite the caveats. It is also worth noting that the issues of cloud cover and look angle will increase the likelihood that the MODIS algorithm misses a fire (Schroeder et al. 2005). With this, the MODIS fire detection from either algorithm can be thought of as a lower bound for the true number of fires. Within ±8.55°, the accuracy of the fire detection for either algorithm is relayed through Figure 8. For MODIS imagery, with a look angle beyond ±15°, the chance of missing a fire is likely higher than the values presented here and will increase as a function of the look angle.

Future efforts are being directed to more fully exploit the radiative information contained in the ASTER data. For example, the cumulative radiance from the ASTER fire detections could be added as a parameter in the logistic regression modeling used to determine MODIS fire detection limits. The cumulative radiance may explain some of the errors of omission.

It is important to realize the difference between the EOS and INPE algorithms. The EOS product is meant for both wildfire management and global climate modeling. The product will be archived and it is meant to serve as a long-term climate data record. The INPE product is primarily produced for fire management purposes. It is a straightforward algorithm that is run on the digital numbers from the MODIS direct broadcast. Indeed, we see from this analysis here that INPE's relatively straightforward, near-real-time algorithm is very similar to the EOS algorithm with respect to omission error, and the INPE algorithm is even superior for larger fires. While the chance of a commission error is very small for both algorithms (primarily because of the large number of nonfires), the EOS algorithm is superior. However, the objective for this paper is not to say which algorithm is better, but rather to simply assess the uncertainty of each through independently derived fire products. It is left to users and further research to build upon the analysis presented here to determine the best use of products from either algorithm or both.